Robot Design

Michael Hartwig

kcFLLref@gmail.com

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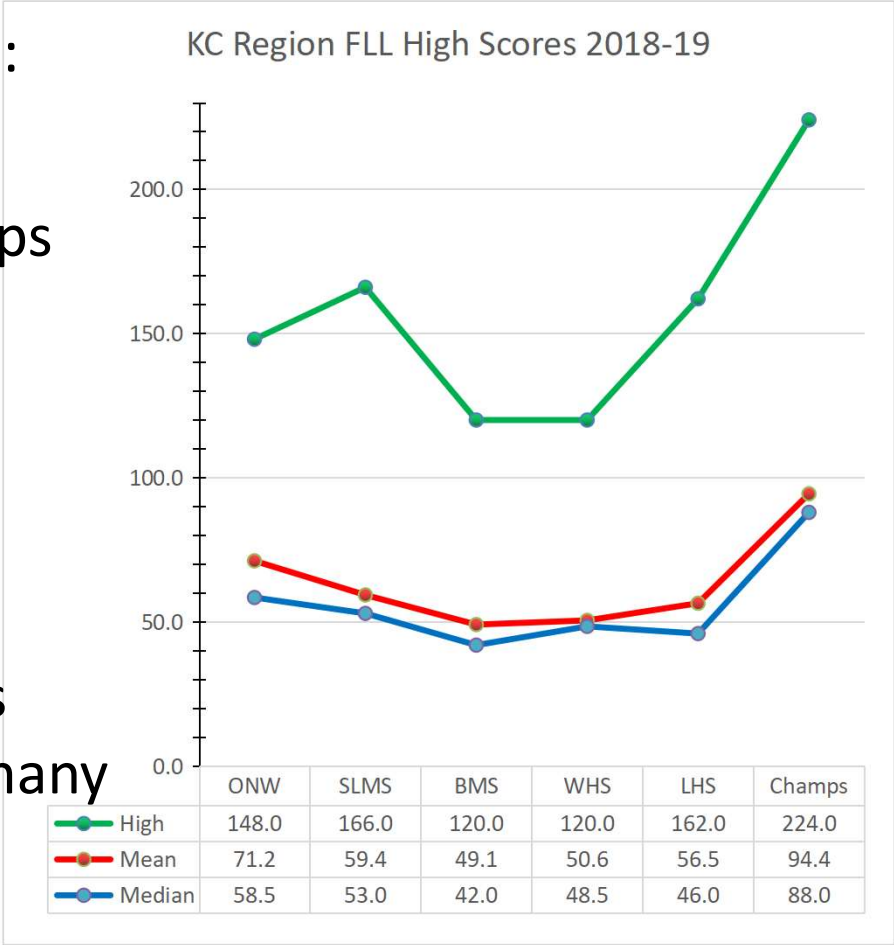
FIRST® LEGO® League

Agenda

- 2018 KC Region robot scores
- Design Factors and Process
- Robot & Attachment Design
- Resources
- Questions

2018 Results

- Statistics from qualifying tournaments & the regional championship
- Top 10 scores for the region:
  - 2 not at Champs
  - 3 scored lower @ Champs
- 45 Champs robots:
  - 25 increased their score
  - 1 stayed the same
  - 19 went down
- Conclusion: more time does not equal higher scores in many cases.



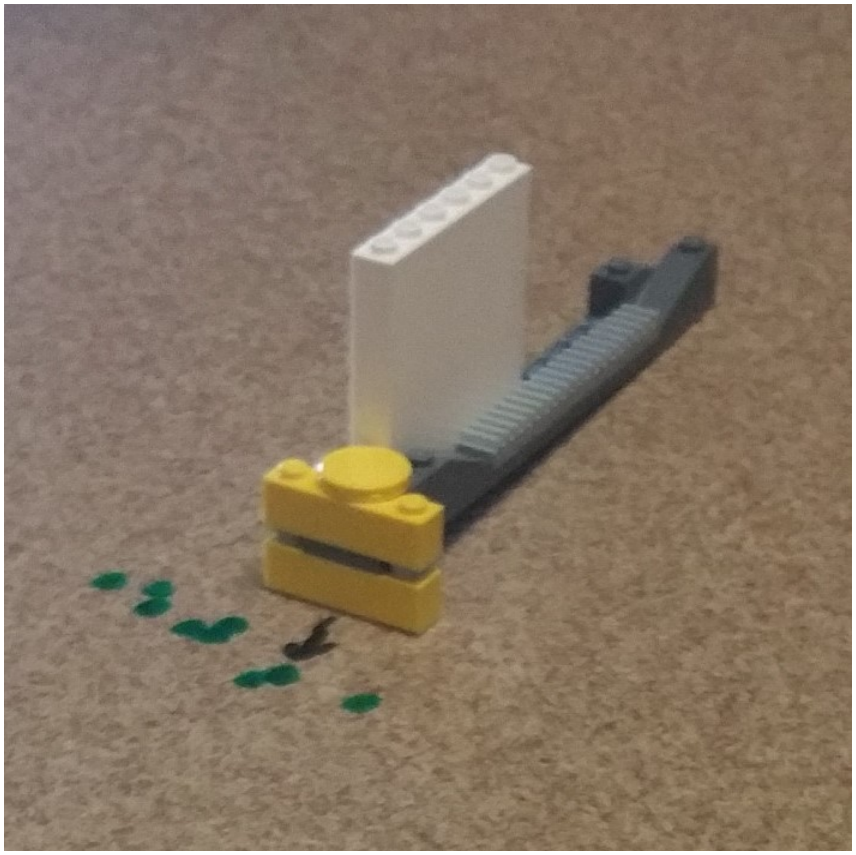
	ONW	SLMS	BMS	WHS	LHS	Champs
High	148.0	166.0	120.0	120.0	162.0	224.0
Mean	71.2	59.4	49.1	50.6	56.5	94.4
Median	58.5	53.0	42.0	48.5	46.0	88.0

Design Factors

- Mindstorms are not high precision devices
  - Sensor accuracy & tolerances
  - Motor & other gear train slippage
  - Limitations of LEGO construction
- 2.5 minutes is a short period of time
  - Time spent in Home or the Launch Area, driving to a mission, or returning to Home is time not scoring
- Tables & models are not all the same
- Self-aligning vs. jigs or manual line-up
  - How *exactly,* repeatably can a robot be set up?
  - Wall following
  - Sensors vs. odometry

Movement Inaccuracy

- Experiment my teams did a couple of years ago
- Kids marked on floor next to wall so they could put the robot down in the “same” place each time.
- Program was move, turn, move. Total distance less than a meter
- Used an attachment to hold a dry erase marker. Robot stopped & we marked the floor.
- Ran 10 times.
- Arrow shows only spot with 2 dots in the same place.



Guiding the Team's Design

- Start simple
  - Don’t let kids go beyond their capabilities
  - They need to understand what they’re creating & how it works
- Plan before building & programming
  - Don't let them just start; they need to think (and hopefully document) first
- Kids need to experiment
  - Formalize, and record results
  - Don’t allow “guess and retry”
  - No assumptions – test & compare variations
- Design for failure
  - Robots can succeed despite inaccuracies and on-field problems, if appropriately designed and programmed.

Coaching

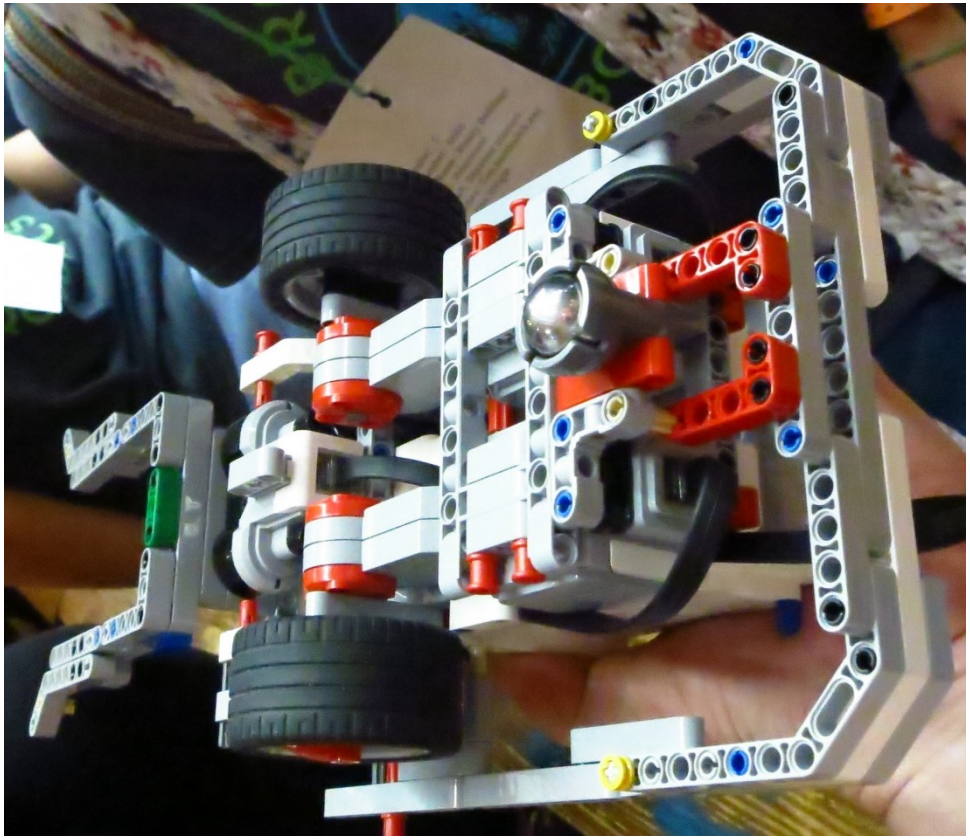
- Main job is to inspire
- Create an environment for success
  - Help the kids learn the rules
    - Need to solve the actual problems presented by the game
    - Rely on themselves
  - Make the game environment realistic
    - Timed practices, with scoring
    - Combine with other teams & have practice sessions
    - Attend rumbles if at all possible; especially rookie teams
- Help team set realistic goals
  - They'll feel more accomplishment reaching small goals then failing at big ones. Steer them towards starting with a small # of missions as a goal; the team can always add more if they finish their original goal.

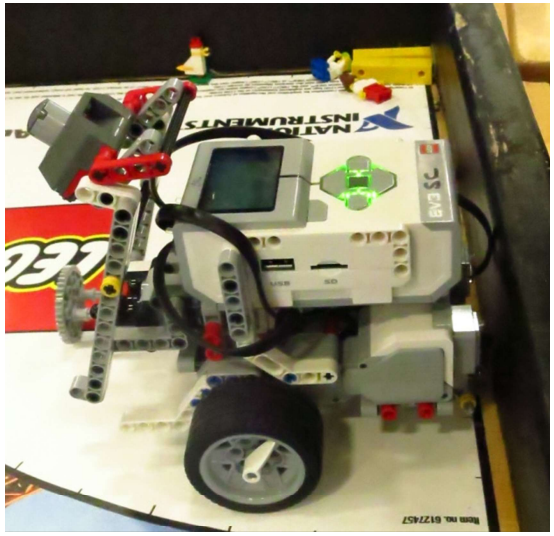
How complicated does a robot need to be?

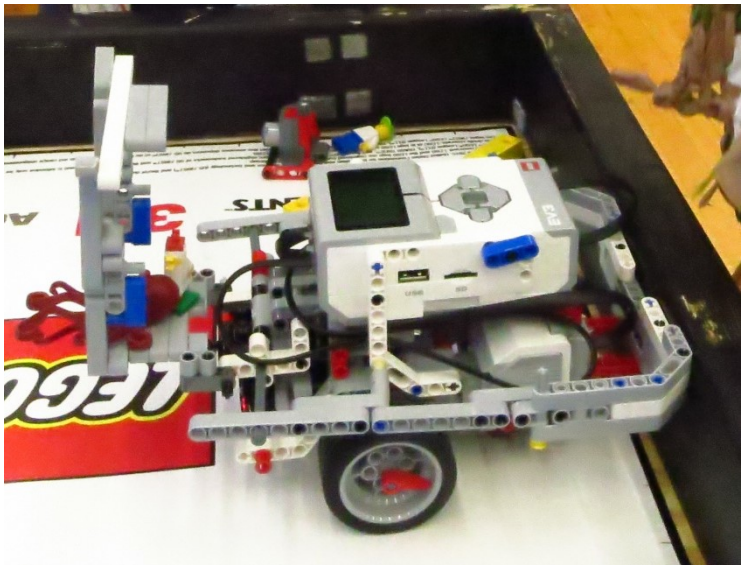
2018-2019 KC Region robot types

	Region Totals		ONW	SLMS	BMS	WHS	LHS	Champs
Complicated	1.7%	3	1	0	1	0	1	3
Custom	34.1%	61	4	17	13	13	14	17
Enhanced Kit	23.5%	42	7	5	8	9	13	14
Kitbot	40.2%	72	7	17	19	18	11	12
NXT	0.6%	1	1	0	0	0	0	0
% Kit-like		63.7%	70.0%	56.4%	65.9%	67.5%	61.5%	56.5%
% Kit		40.2%	35.0%	43.6%	46.3%	45.0%	28.2%	26.1%

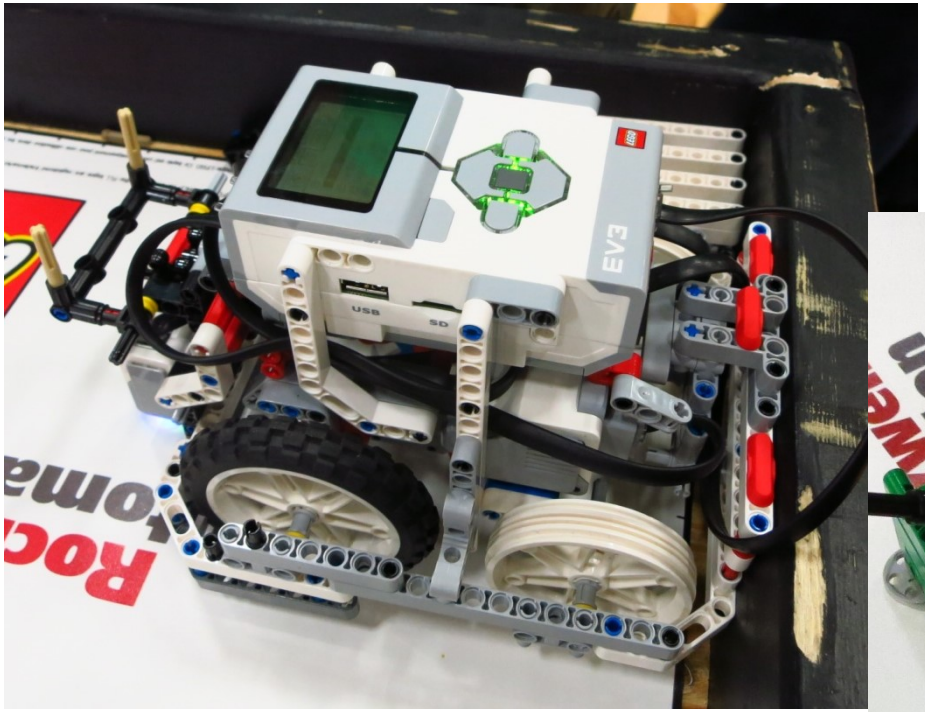
Robots – Kitbots & mods

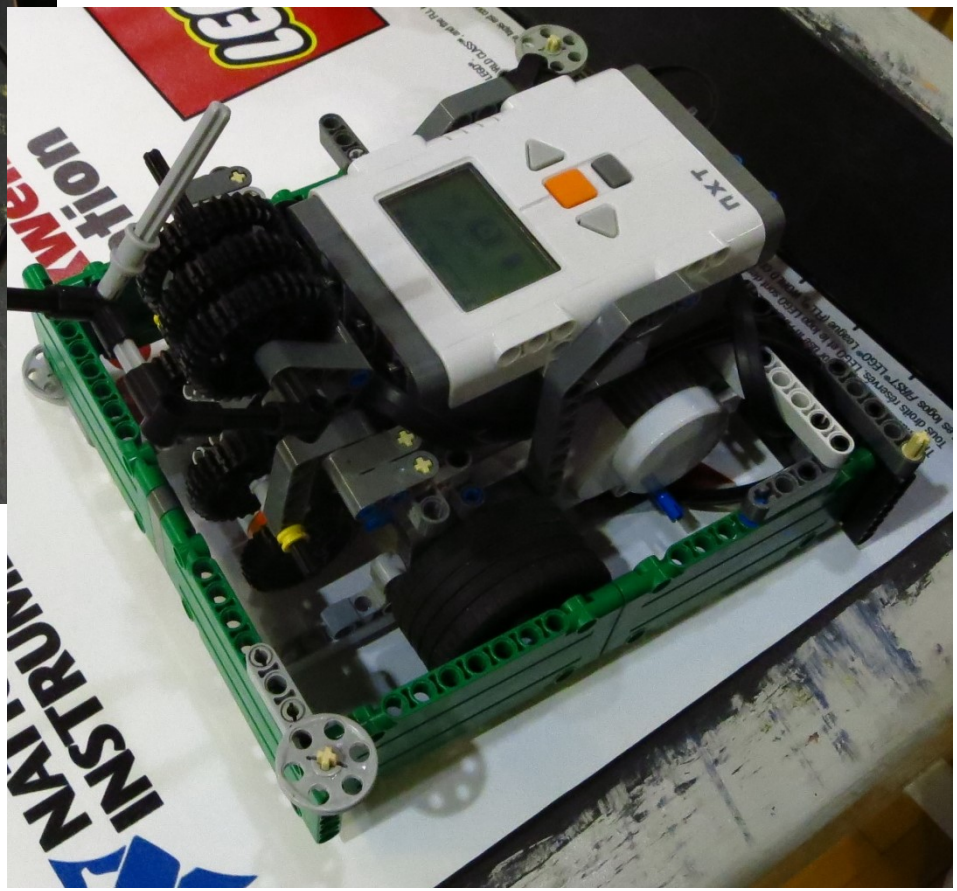


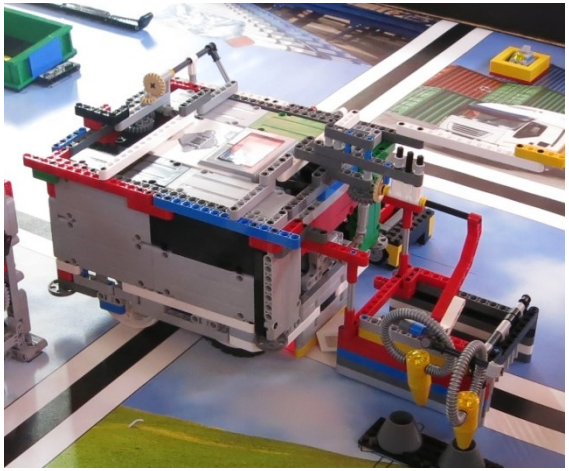




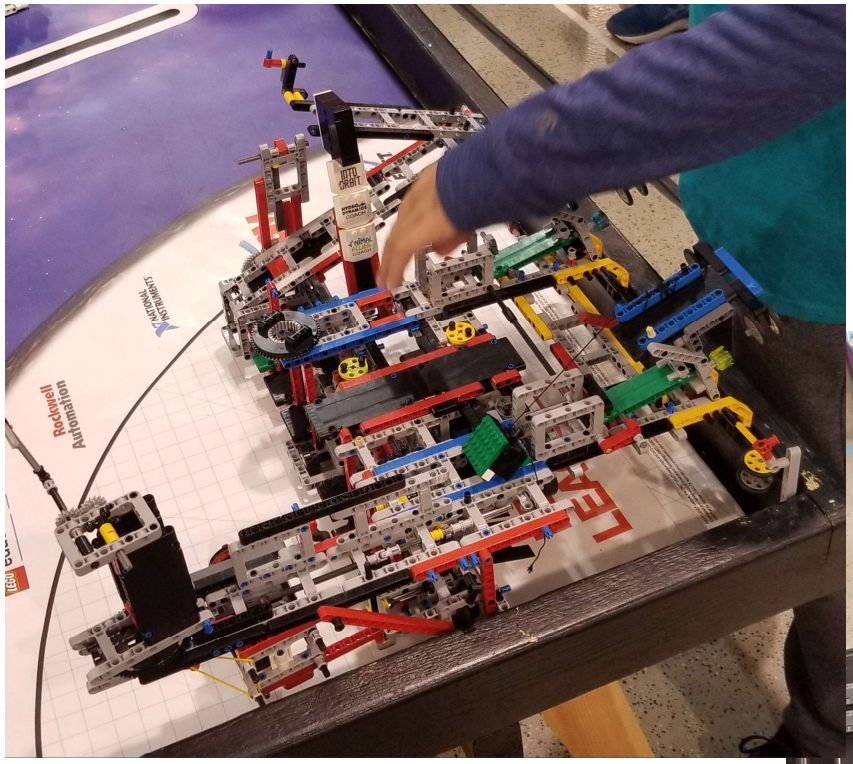
Robots - Custom

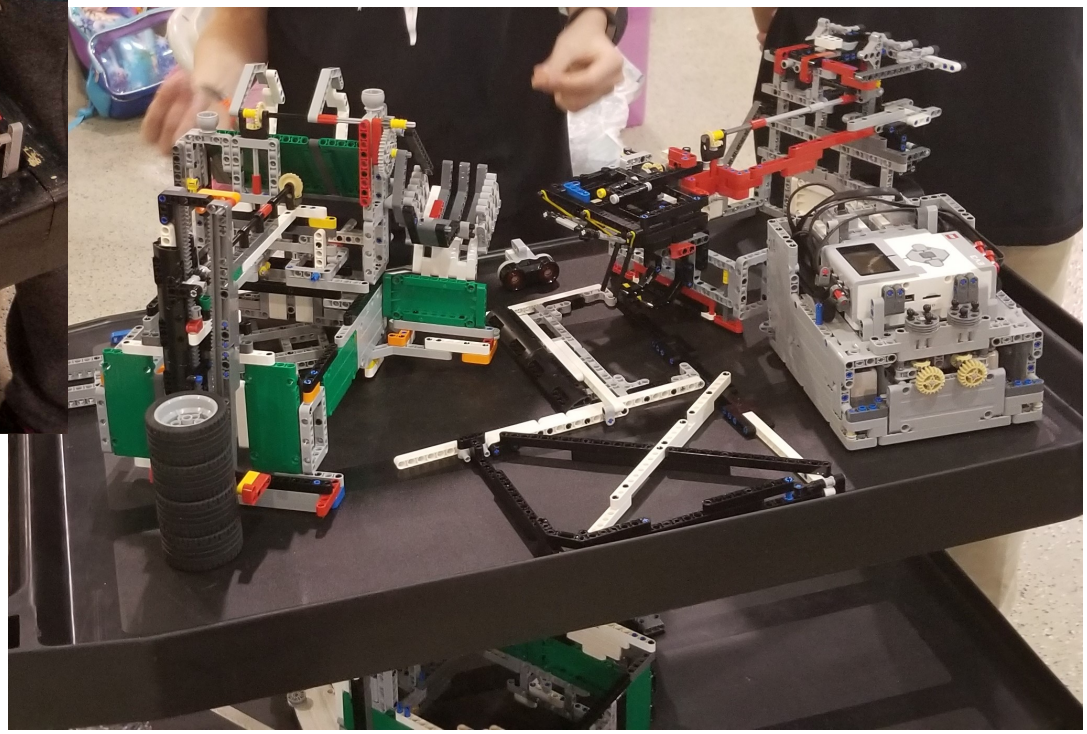




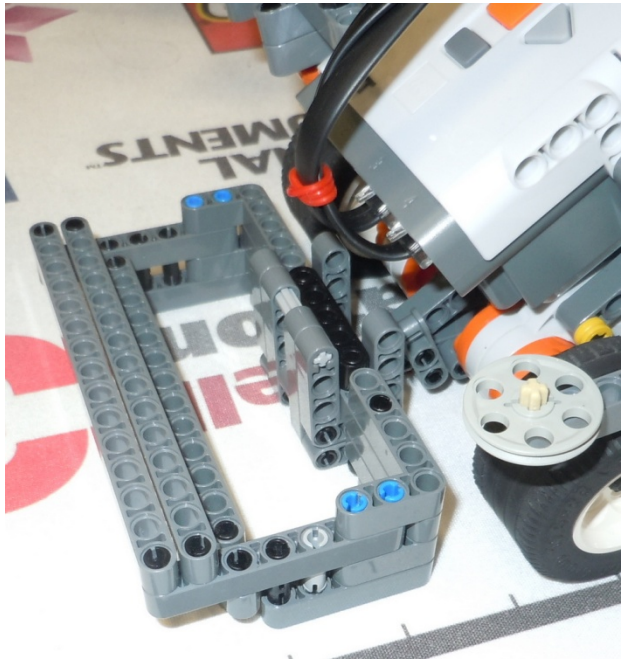


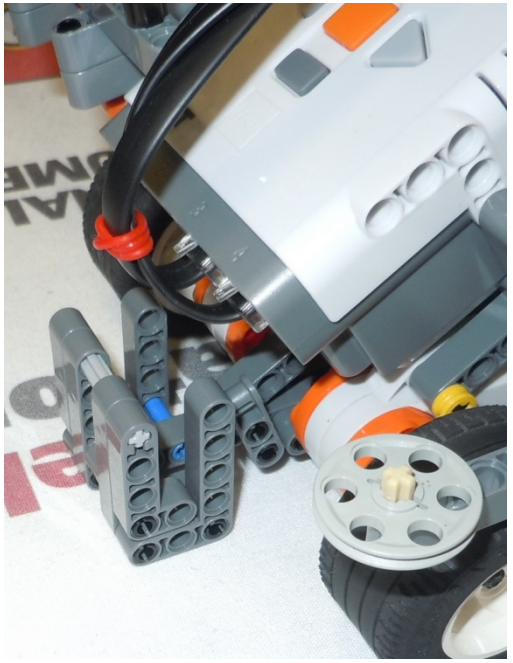
Robots -- Complicated



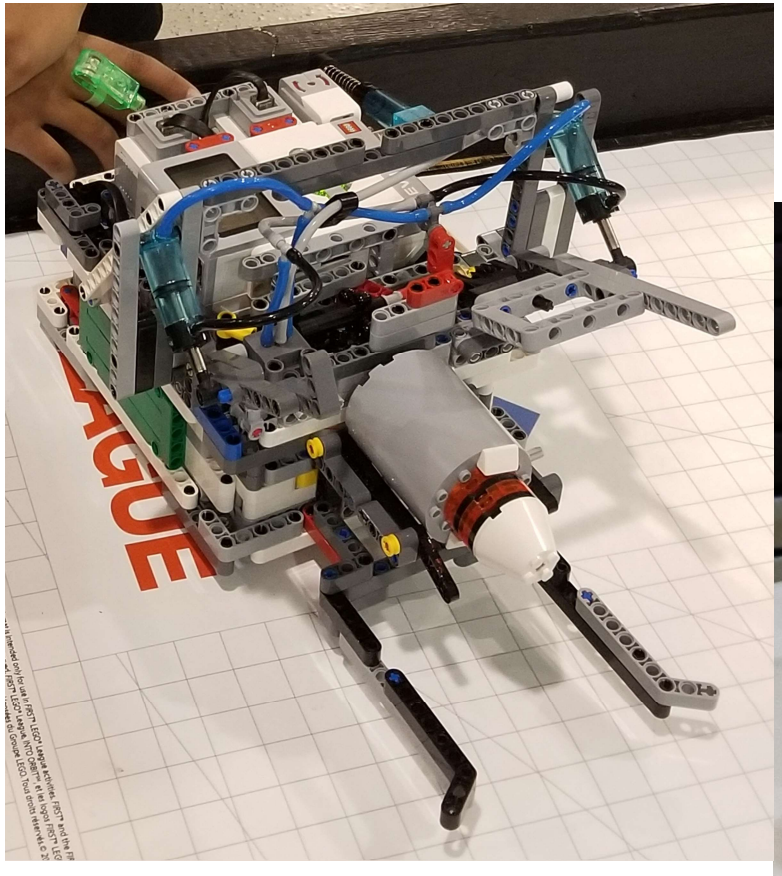


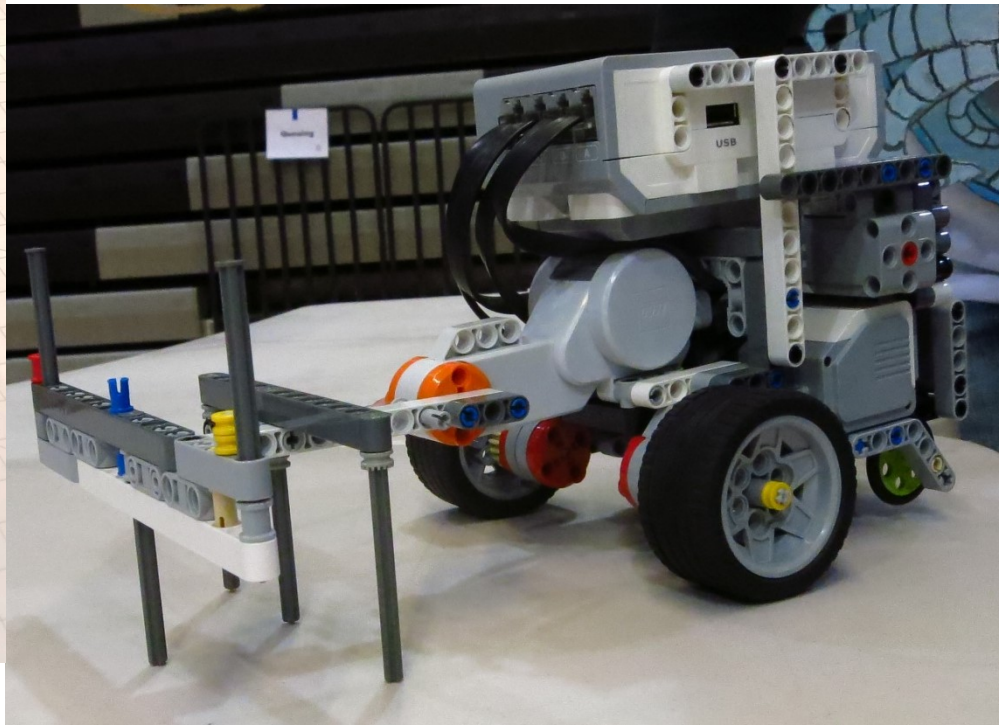
Robots – Quick-change attachments



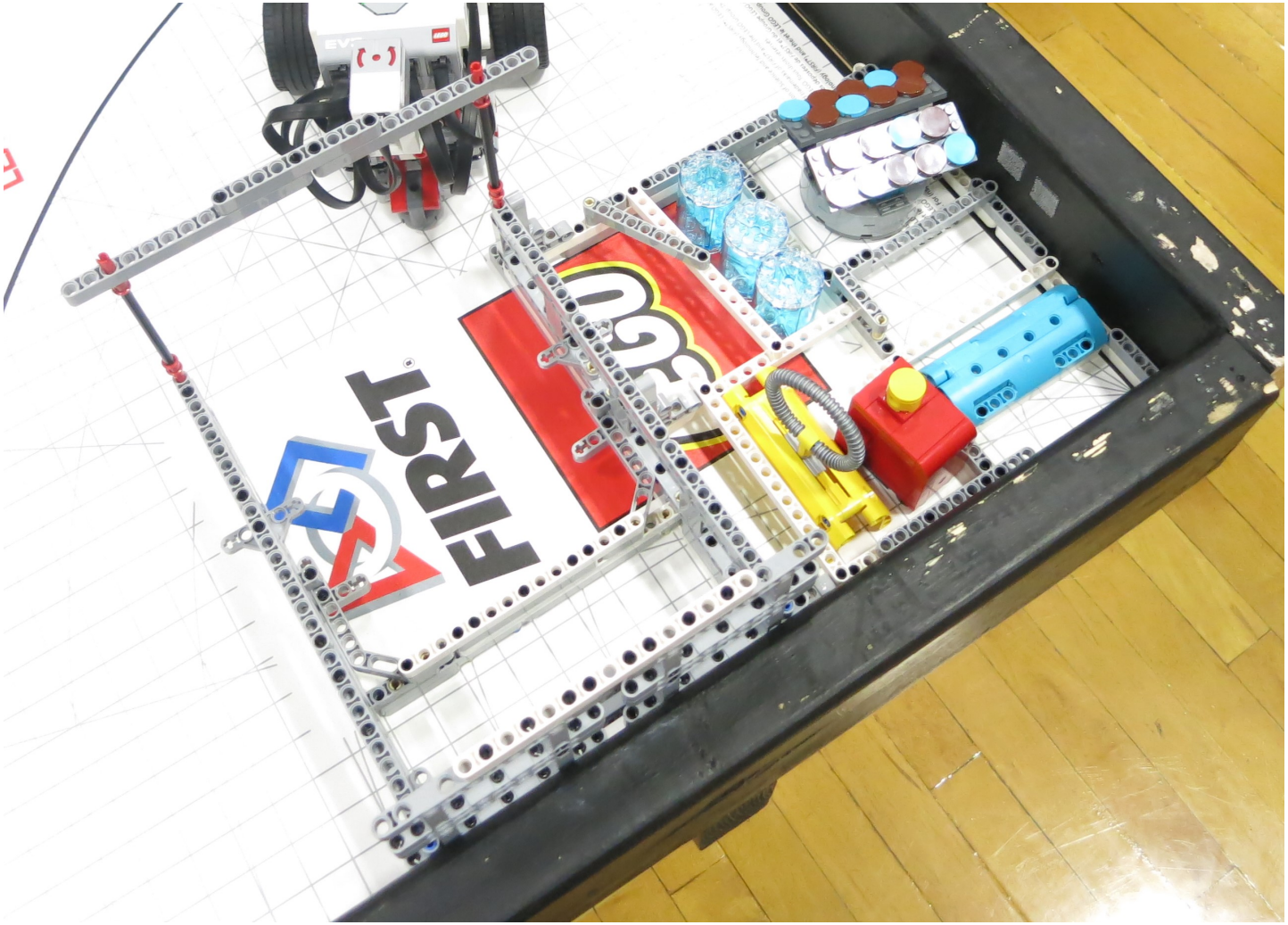


Robots – Passive attachments





Robots – Table Organization



Construction

- Build solid robots: Don’t rely on single pegs to join beams – use “L” beams to join angles or short beams to splice 2 long beams
- I love the “2M Friction Pin with Cross Hole” pins for attachments. They don't come out and therefore don’t have to be removed before putting on the next attachment.

- Align & position sensors correctly
  - Color / light – not too close or too far from mat; completely perpendicular.
  - Touch sensors – position or build so triggering doesn’t twist the robot
  - Ultrasonic – make sure they’re below the top of the surface being detected, and perpendicular
  - Gyro – mount horizontally.
- Team needs to check robot connections regularly - make sure it's staying together. Should be part of their post- and pre-match checklists.
- Consider the robot's center of gravity when adding attachments

Resources

- FLL web site: https://www.firstinspires.org/resource-library/fll/challenge-and-resources
- FLL First steps: https://info.firstinspires.org/fll-first-steps-request
- KC FIRST FLL portal: https://www.kcfirst.org/first-lego-league-portal
- FLL forums: https://forums.usfirst.org/forum/general-discussions/first-programs/first-lego-league
- EV3Lessons: http://ev3lessons.com/
- TechBrick: https://techbrick.com/fll-resources/fll2019
- Books:
  - FIRST LEGO League: The Unofficial Guide - https://www.amazon.com/First-LEGO-League-Unofficial-Guide/dp/1593271859
  - Winning Design!: LEGO Mindstorms EV3 Design Patterns for Fun and Competition - https://www.amazon.com/Winning-Design-MINDSTORMS-Patterns-Competition/dp/1484221044/ref=pd_sim_14_6?_encoding=UTF8&psc=1&refRID=57EBR5VZ9M3VCRDXHP4R

Questions?